

GONYAULAX MONILATA, SP. NOV., THE CAUSATIVE  
DINOFLAGELLATE OF A RED TIDE ON THE EAST  
COAST OF FLORIDA IN AUGUST-  
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In late August, 1951, the staff of the Red Tide Investigation, U. S. Fish and Wildlife Service, Sarasota, Florida, was notified of a fish-kill and discoloration of the water of the Indian River, a marine lagoon on the East coast of Florida. Preliminary examination showed that the discoloration was caused by large numbers of dinoflagellates but that no great quantity of fish were killed. A temporary laboratory was established in Melbourne, Florida for the purpose of studying this "red tide."<sup>1</sup>

Analysis of the chemical and biological samples and the bearing of these data on the problem of more extensive and destructive red tides will be reported in a later paper.

*Gonyaulax monilata*, sp. nov.

DIAGNOSIS. A small species that forms chains up to forty cells in length (Figure 2.); the plate pattern is 4', Oa, 6'', 6, 6''', 1p, 1''''; theca minutely punctate, with no spines or lists; length  $37\ \mu$  (24.1 to  $51.6\ \mu$ ), transdiameter  $57\ \mu$  (37.8 to  $75.7\ \mu$ ); in coastal plankton of Florida.

DESCRIPTION. *Gonyaulax monilata* is sub-spherical, flattened antero-posteriorly, the length being 0.6–0.8 times the transdiameter. A very slight dorsoventral flattening makes the dorsoventral diameter 0.8–0.9 times the transdiameter. The epitheca is slightly longer than the hypotheca due to the convexity of the apex and the concavity of the antapex.

The girdle is subequatorial, descending and displaced approximately one girdle width, with no overhang, deeply impressed and composed of six plates.

The ventral area is narrow anteriorly, widening posteriorly and is slightly impressed into the hypotheca, thus forming most of the longitudinal furrow. The ventral area is composed of four platelets (Figure 1), one anterior (ap), two intermediate (ip), and one posterior (pp). The posterior plate of the ventral area is rhomboid and is marked by six to ten radial lines (Figure 5). This plate is impressed about one-half girdle width into the hypotheca and contains the posterior attachment pore (p) on a small prominence in the center of the plate.

The plate formula is 4', Oa, 6'', 6, 6''', 1p, 1'''''. In addition there is the closing plate of the apex (cl. pl., Figure 4). Apical 1 (1'?, Figures 1 and 4) has become so constricted anteriorly that it has lost contact with the apex. Apical 1' is indented in the region of the girdle by the anterior plate of the ventral area.

<sup>1</sup>In this report the term "red tide" is defined as discoloration of brackish or salt water caused by large numbers of organisms, with or without accompanying mortality of aquatic life.

The sulcus extends from the girdle to the antapex and is composed of the ventral area with small contributions from postcingulars 1''' and 6'''. Postcingular 1''' is very small and is rectangular.

In addition to the anterior attachment pore (A, Figures 1 and 4) there is another pore in the closing plate of the apex. This pore is lunate and is here called the ventral pore (V).

Chains are produced by repeated fission and protoplasmic continuity is accomplished by a slender strand of protoplasm passing through the the anterior and posterior attachment pores. These pores were observed in all specimens regardless of location in the chain.

The cytoplasm is reddish-brown and packed with granular bodies. Vacuoles that stain with Sudan IV are arranged peripherally. An iodine test for starch produced no blue color.

The nucleus (Figure 3), with moniliform chromatin threads, is large and lunate and the open end is always oriented ventrally.

The length and transdiameter were measured in 970 specimens. The mean length is  $37.4\ \mu$  (range =  $24.1$ – $51.6\ \mu$ ; standard deviation =  $4.6\ \mu$ ) and the mean transdiameter is  $57.4\ \mu$  (range =  $37.8$ – $75.7\ \mu$ ; standard deviation =  $5.7\ \mu$ ). The mean dorsoventral diameter, as determined by measurement of 157 single individuals (not in chains), is  $49.7\ \mu$  (range =  $34.4$ – $61.9\ \mu$ ; standard deviation =  $4.8\ \mu$ ) and the girdle width is approximately  $5\ \mu$ .

**DISTRIBUTION.** Taken in plankton from all stations in the Indian and Banana Rivers, Florida in August and September 1951 (salinity range = 18 to 32 ‰; temperature range =  $30^{\circ}$  to  $34^{\circ}$  C.) and in one sample at City Pier, Sarasota, Florida, on September 14, 1951.

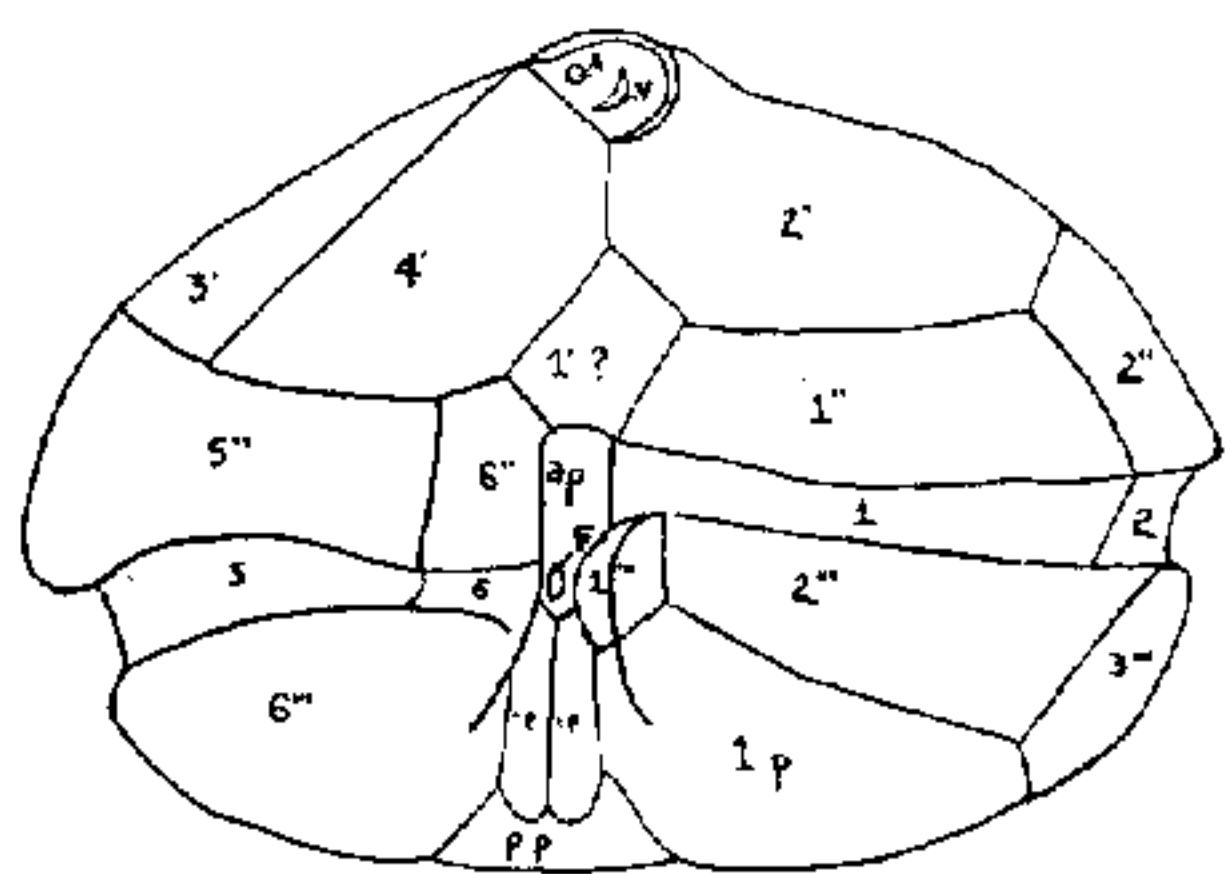
**COMPARISONS.** Although *Gonyaulax monilata* and *G. catenella* Whedon and Kofoid (1936) seem to be closely related, the patterns of thecal sutures manifest significant differences. These differences are so great, in fact, as to cast some doubt on the inclusion of the present species in the genus *Gonyaulax* as described by Diesing and emended by Kofoid (1911a). This description of the genus allows no variation in the number of precingular plates.

The most significant difference between *Gonyaulax monilata* and *G. catenella* is in what is here called the first apical plate (1'?, Figures 1 and 4). If this is an apical plate the anterior constriction evident in many species of *Gonyaulax* (e.g. *G. polyedra*, *G. polygramma*, *G. scrippsae*) has been carried to the ultimate extreme and the plate is so constricted as to have lost contact with the apex. Such extreme constriction could conceivably result from rapid multiplication associated with chain formation.

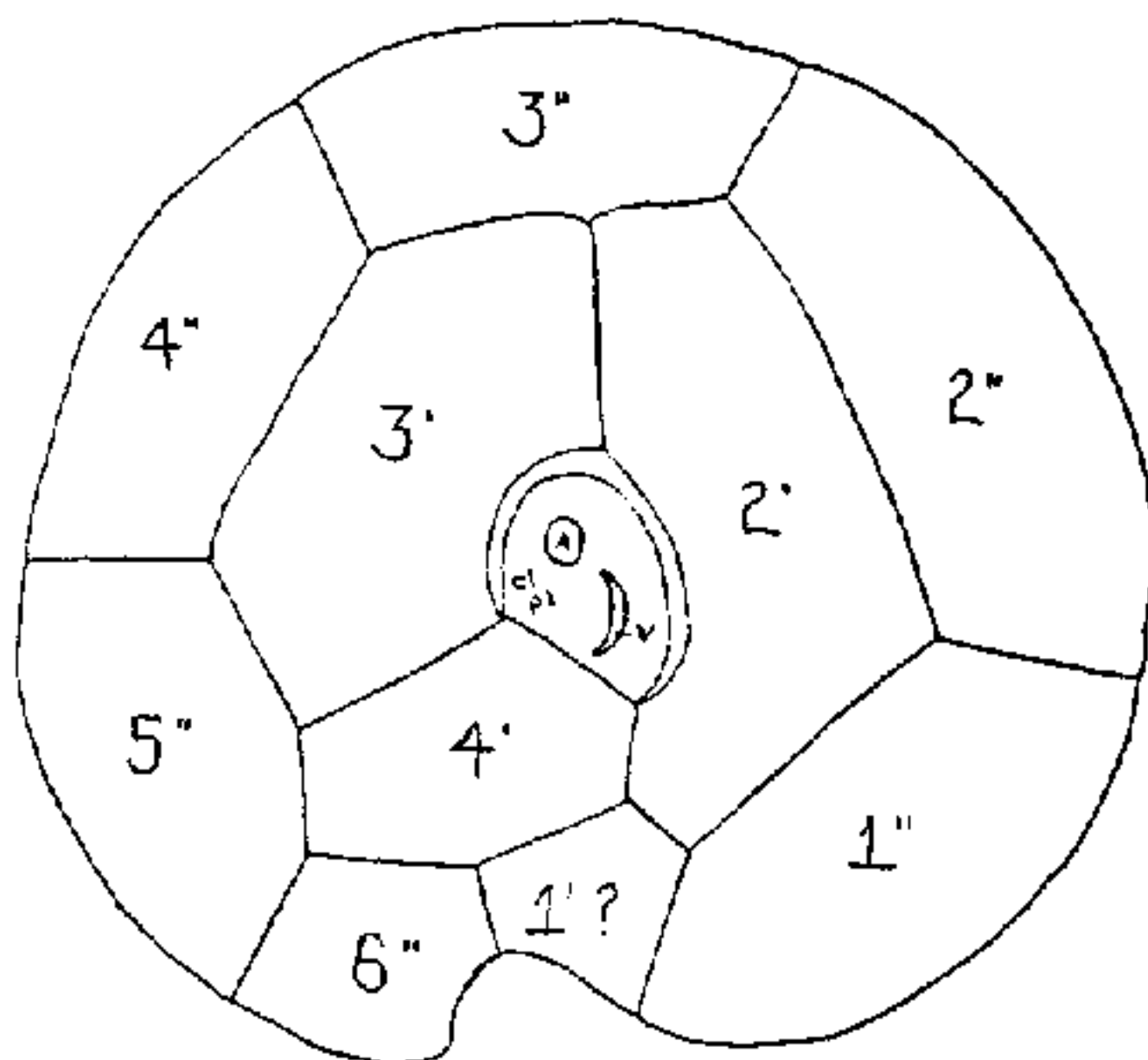
The alternative interpretation of this plate is as a precingular. This would make the number of apicals three and the number of precingulars seven. By traditional taxonomical procedure the present species would then be excluded from the genus *Gonyaulax* and would take a place as the type species of a poorly defined genus. This alternative is not attractive to the author and does not seem justified at this juncture.

On the basis of the plate pattern of the hypotheca (which does not vary in *Gonyaulax*) and the interpretation of plate 1' ? as an apical by virtue of its relation to precingulars 1'' and 6'' and the anterior plate of the ventral area, the present species is assigned to the genus *Gonyaulax*.

pending a re-examination and redescription of this genus and the small genera closely related to it.



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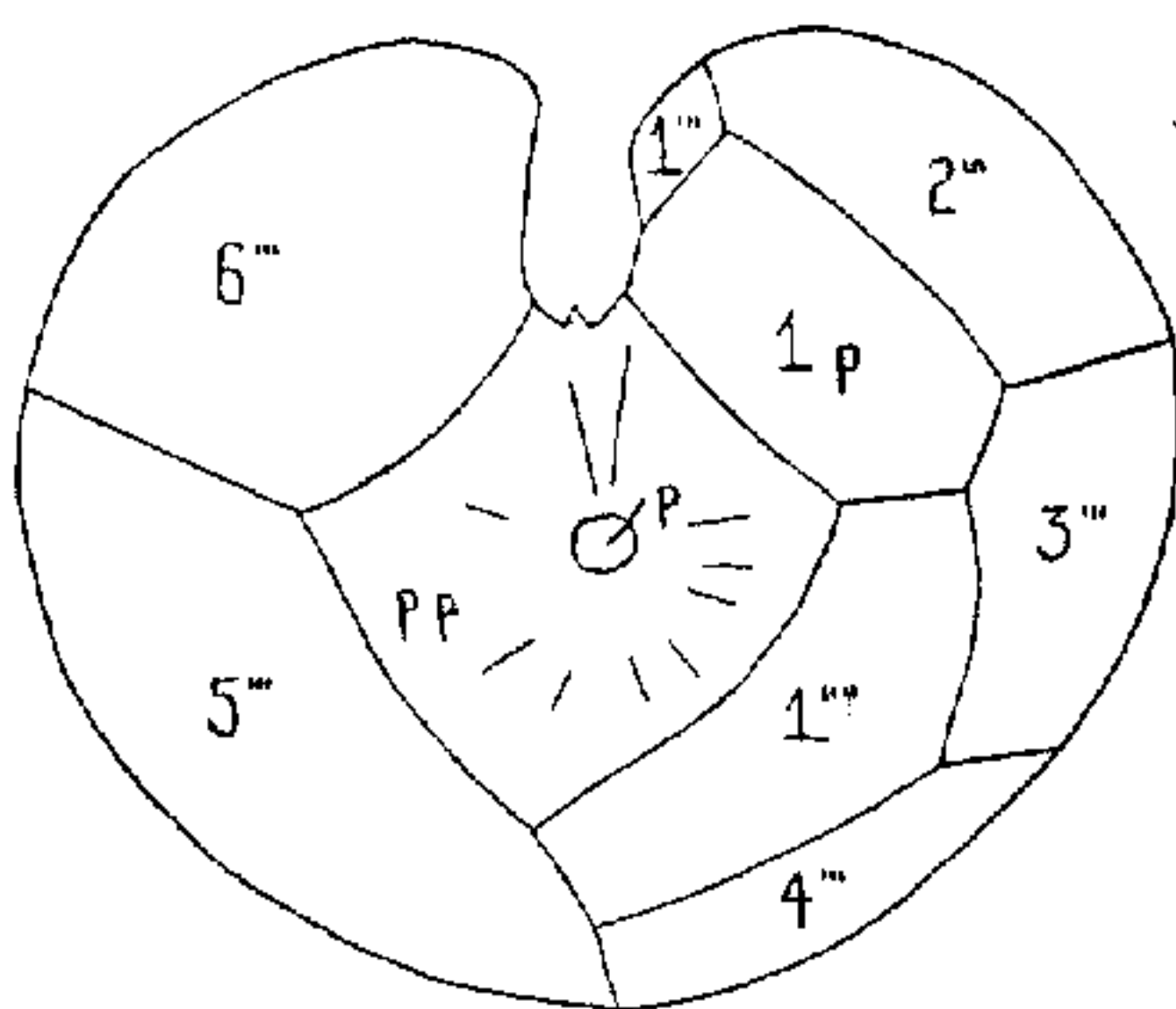
4



2



3



5

FIG. 1. Ventral view of *Gonyaulax monilata* sp. nov. ( $\times 735$ ).

FIG. 2. Four individuals in catena ( $\times 160$ ).

FIG. 3. Apical view of nucleus ( $\times 1000$ ).

FIG. 4. Plate pattern of epitheca ( $\times 1000$ ).

FIG. 5. Plate pattern of hypotheca ( $\times 1000$ ).

ABBREVIATIONS: 1'-4', apical plates; 1''-6'', precingular plates; 1-6, girdle plates; 1'''-6''', postcingular plates; 1''', antapical plate; 1 p, posterior intercalary plate; ap, anterior plate of ventral area; ip, intermediate plates; pp, posterior plate; A, anterior attachment pore; P, posterior attachment pore; V, ventral pore; F, flagellar pore.

This assignment is further strengthened by the similarity, both morphological and physiological (synthesis of a toxin), to *Gonyaulax catenella*.



*Gonyaulax monilata* also bears a very general resemblance to two other catenulate forms, *G. catenata* (Levander) Kofoid and *G. series* Kofoid and Rigden. It differs from the former in the number and arrangement of apical plates (Kofoid 1911b) and from the latter in the form of protoplasmic continuity (Kofoid and Rigden 1911).

Connell and Cross (1950) described a red tide in Offatts Bayou, Galveston, Texas, and attributed it to a dinoflagellate they believed to be *Gonyaulax catenella*. Since specific identification was not made and the plate pattern was not reported, accurate comparison with *G. monilata* is not possible.<sup>2</sup>

REMARKS. The difficulty in determining the generic relationship of this organism stresses the need for a revision of the genus *Gonyaulax* and related genera.

#### LITERATURE CITED

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<sup>2</sup>On September 5, 1952, the author examined a sample from Offatts Bayou containing a chain-forming dinoflagellate. The plates were identical to those of *Gonyaulax monilata* and measurement of 50 specimens gave the following mean dimensions: Transdiameter—50.3  $\mu$ ; Length—33.6  $\mu$ . The mean dorsoventral diameter of ten specimens was 48.3  $\mu$ .